ECR ETCHING DEVICE

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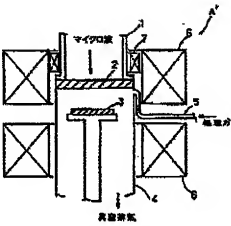
Abstract of **JP6005548**

PURPOSE:To make an etching configuration vertical to a sample and to reduce damage to the sample by arranging the sample in a central axial intermediate part of a coil group and by arranging an auxiliary coil concentrically with the coil group in an area near the coil group to change profile of a magnetic field. CONSTITUTION:A sample substrate 3 is arranged in a central axial intermediate part of magnetic coils 6, 6 and an auxiliary coil 7 is arranged concentrically with the magnetic coils 6, 6 inside the magnetic coils 6, 6. Magnetic field profile generated by the magnetic coils 6, 6 is changed by the auxiliary coil. That is, direction of magnetic force line from an ECR surface to the sample substrate 3 is made uniform to control movement direction of ion vertically to the sample substrate 3. Thereby, it is possible to maintain etching performance such as high etching velocity and high selectivity, to make etching configuration vertical to the sample substrate 3 and to reduce damage to the sample substrate 3.



PATENT ABSTRACTS OF JAPAN

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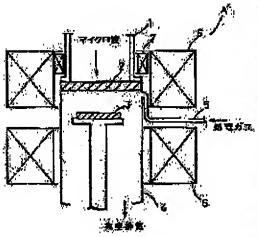
(54) ECR ETCHING DEVICE



(57)Abstract:

PURPOSE: To make an etching configuration vertical to a sample and to reduce damage to the sample by arranging the sample in a central axial intermediate part of a coil group and by arranging an auxiliary coil concentrically with the coil group in an area near the coil group to change profile of a magnetic field.

CONSTITUTION: A sample substrate 3 is arranged in a central axial intermediate part of magnetic coils 6, 6 and an auxiliary coil 7 is arranged concentrically with the magnetic coils 6, 6 inside the magnetic coils 6, 6. Magnetic field profile generated by the magnetic coils 6, 6 is changed by the auxiliary coil. That is, direction of magnetic force line from an ECR surface to the sample substrate 3 is made uniform to control movement direction of ion vertically to the sample substrate 3. Thereby, it is possible to maintain etching performance such as high etching velocity and high selectivity, to make etching configuration vertical to the sample substrate 3 and to reduce damage to the sample substrate 3.

CLAIMS

[Claim(s)]
[Claim 1]A magnetic field generating means which generates a magnetic field by sending current through a uniform direction at at least one pair of magnetic coil groups installed side by side, Have an electric field generating means which introduces microwave in a magnetic field generated by the above-mentioned magnetic field generating means, and generates an electric field, and by the above-mentioned magnetic field generating means. By an interaction of a magnetic field to generate and an electric field generated by the above-mentioned electric field generating means. In an ECR etching device which performs an etching process by irradiating a sample with ion in raw gas plasma-ized using a electron cyclotron resonance phenomenon to produce, An ECR etching device which the above-mentioned sample is arranged to pars intermedia of the above-mentioned magnetic coil center-of-group shaft orientations, and forms an auxiliary magnet to which a profile of a magnetic field which is allocated in this magnetic coil group and the same mind near the above-mentioned magnetic coil group, and is generated by the above-mentioned magnetic field generating means is changed, and is characterized by things.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to an ECR etching device, and relates to the ECR etching device used for manufacture of LSI etc. in detail.
[0002]
[Description of the Prior Art]In recent years, in manufacture of LSI etc., the ECR etching process method which is a lithography technology by a plasma reaction is used widely. The ECR etching device which performs an etching process, By the magnetic field and microwave. An etching process is performed by irradiating a sample substrate with the ion in the raw gas plasma-ized using the electron cyclotron resonance (Electron Cyclotron Resonance, ECR) phenomenon produced by an interaction with the electric field to generate. The mimetic diagram and drawing 6 in which the outline composition in an example of ECR etching device A of the former [drawing 5] is shown are an explanatory view showing the line-of-magnetic-force profile in ECR etching device A, etc. As shown in drawing 5, in the conventional device A, microwave is introduced into the vacuum housing 4 into which the sample substrate 3 went from the microwave introducing window 2 which is oscillated from the microwave oscillator which is not illustrated and consists of quartz glass plates via the waveguide 1. Raw gas is introduced into the vacuum housing 4 from the raw gas feed port 5. A mirror magnetic field is impressed in the vacuum housing 4 by sending current through the magnetic coils 6 and 6 arranged so that this may be surrounded around the vacuum housing 4 in a uniform direction. As microwave, the 2.45-GHz thing which is generally industrial frequency is used. Therefore, the magnetic field intensity (magnetic flux density) which fulfills ECR conditions is set to 875G (gauss), and this field of 875G turns into an ECR surface where the maximum plasma density is obtained. Usually, in this kind of ECR etching device A, as shown in drawing 6, microwave is introduced from the high magnetic field side. That is, microwave is spread from the one where magnetic field intensity is larger than 875G, and plasma absorption is carried out in the place used as 875G. Then, the electron (e^-) by which it was generated rotates to the circumference of the right at right angles to a magnetic field, and exercises in the direction of a line of magnetic force. When an emission magnetic field as shown in drawing 6 is used, an electron (e^-) coils around a line of magnetic force, it exercises for an oblique direction, and ion (+) exercises in the direction of the initial velocity. For this reason, an electric field occurs according to the charge separation of plasma which an electron (e-) and ion (+) leave as it separates from a plasma generation place (ECR surface), and plasma is spread with an ExB drift. Therefore, it is irradiated to the sample substrate 3,

magnetic field intensity diffusing the charged particle (ion (+) and electron (e^-)) in plasma at **** by the above-mentioned emission magnetic field which becomes weak in the sample substrate 3 direction which separated a few from the ECR surface and has been arranged. The etching process of the sample substrate 3 is performed by this exposure. In this case, since electric charge particles are diffused by an emission magnetic field, the ion energy and the ion density which enter into the sample substrate 3 become small, and a high etch rate is not obtained. For this reason, the art which raises an etch rate is publicly known by impressing high frequency to the sample table with which the sample substrate 3 is laid, and giving a DC bias (JP,60-134423,A). These days, an ECR surface is formed near the sample table, and what was made to perform an etching process is developed, without impressing high frequency to a sample table (JP,3-259517,A).

[0003]

[Problem(s) to be Solved by the Invention]The following problems may be produced in conventional ECR etching device A which was described above.

** Since the emission magnetic field is used, a line of magnetic force may not enter vertically over the 3rd page of the whole sample substrate, but the side attachment wall etched in sample substrate 3 periphery may incline. Namely, since the movement directions of an electron (e^-) and ion (+) differ, The electric field which was in disorder according to charge separation of plasma occurs, the movement direction of ion (+) is disturbed by this and an etching configuration may serve as a back taper (phenomenon in which the pars basilaris ossis occipitalis becomes thin from the upper part of the etched pattern), by it (refer to drawing 7).

** In order to compensate the fall of the etch rate by using an emission magnetic field, in the thing impresses high frequency to a sample table and he is trying to raise an etch rate, there is a tendency for the selection ratio of etching objects, such as polysilicon, and grounds, such as silicon oxide (SiO_2), to become small. For this reason, it is difficult to process an etching object selectively.

** In what formed the ECR surface in about three sample substrate, although a high etch rate and a high selection ratio are obtained, an ECR surface may shift to the high magnetic field or lower field side by movement of the electron (e^-) in plasma. Therefore, change of the etch rate by gap of the slight position of the sample substrate 3 is large, and tends to produce the problem of reproducibility. Microwave reached to the sample substrate 3, heat by microwave of the sample substrate 3 was carried out, and there was a possibility of giving a damage to the sample substrate 3 – heating of the sample substrate 3 and the device on the sample substrate 3 receiving a damage.

Improving an ECR etching device and maintaining etching performances, such as a high etch rate and a high selection ratio, in order that this invention may solve the technical problem in such a Prior art. It aims at providing the ECR etching device which can make an etching configuration vertical to a sample, and can reduce the damage to a sample.

[0004]

[Means for Solving the Problem]To achieve the above objects, a magnetic field generating means which generates a magnetic field when this invention sends current through a uniform direction at at least one pair of magnetic coil groups installed side by side, Have an electric field generating means which introduces microwave in a magnetic field generated by the above-mentioned magnetic field generating means, and generates an electric field, and by the above-mentioned magnetic field generating means. By an interaction of a magnetic field to generate and an electric field generated by the above-mentioned electric field generating means. In an ECR etching device which performs an etching process by irradiating a sample with ion in raw gas plasma-ized using a electron cyclotron resonance phenomenon to produce, Arrange the above-mentioned sample to pars intermedia of the above-mentioned magnetic coil center-of-group shaft orientations, and. It is constituted as an ECR etching device which forms an auxiliary magnet to which a profile of a magnetic field which is allocated in this magnetic coil group and the same mind near the above-mentioned magnetic coil group, and is generated by the above-mentioned magnetic field generating means is changed, and is characterized by things.

[0005]

[Function]According to this invention, a sample is arranged in the pars intermedia of the magnetic coil center-of-group shaft orientations which constitute a magnetic field generating means, and an auxiliary magnet is allocated in this coil group and the same mind near the above-mentioned coil group, and the profile of the magnetic field generated by the above-mentioned auxiliary magnet by the above-mentioned magnetic field generating means is changed. That is, the direction of the line of magnetic force from an ECR surface to a sample can be arranged, and the movement direction of ion can be perpendicularly controlled to the above-mentioned sample. As a result,

the ECR etching device which can make an etching configuration vertical to a sample, and can reduce the damage to a sample can be obtained, maintaining etching performances, such as a high etch rate and a high selection ratio.

[0006]

[Example]It explains hereafter per [which materialized this invention with reference to the accompanying drawing] example, and an understanding of this invention is presented. The following examples are examples which materialized this invention, and are not the things of the character which limits the technical scope of this invention. The explanatory view and drawing 3 in which a magnetic field profile [in / in the mimetic diagram and drawing 2 in which the outline composition of ECR etching device A' which drawing 1 requires for one example of this invention is shown / ECR etching device A'] etc. are shown here the etching configuration of the sample substrate by ECR etching device A'. The section enlarged drawing and drawing 4 which are shown show the mimetic diagram showing the outline composition of ECR etching device A" concerning other examples of this invention. The same numerals are used for the element which is common in the mimetic diagram showing the outline composition in an example of the conventional ECR etching device A shown in said drawing 5. As shown in drawing 1, ECR etching device A' concerning this example, The point provided with the microwave oscillator (un-illustrating), the waveguide 1 and the microwave introducing window 2 equivalent to an electric field generating means, the vacuum housing 4 into which the sample substrate 3 equivalent to a sample was put, the raw gas feed port 5, and the magnetic coils 6 and 6 equivalent to a magnetic field generating means is the same as that of a conventional example. However, in this example, arrange the sample substrate 3 to the pars intermedia of the axis direction of the magnetic coils 6 and 6, and, The auxiliary coil 7 (equivalent to an auxiliary magnet) is allocated inside the magnetic coils 6 and 6 at the magnetic coils 6 and 6 and the same mind, and it differs from a conventionel example in that the magnetic field profile generated by the magnetic coils 6 and 6 is changed with the auxiliary coil 7. In this example, a mainly different portion from a conventional example is explained, and since it is as the previous statement about the same portion as a conventional example, the detailed explanation is omitted. Hereafter, operation of etching device A' concerning this example is explained. A mirror magnetic field is impressed in the vacuum housing 4 by sending the exciting current same to a uniform direction through the magnetic coils 6 and 6 first. If the sample substrate 3 is arranged to the pars intermedia of the axis direction of the magnetic coils 6 and 6, the uniform magnetic field of 875G (gauss) will be formed near the sample substrate 3. Next, an about two-microwave introducing window magnetic field is made larger than 875G by energizing to the auxiliary coil 7. At this time, microwave is introduced in the vacuum housing 4 from the high magnetic field side, as shown in drawing 2, and it spreads the inside of plasma by the whistler wave transmitted in parallel with a magnetic field. And the high density plasma in which microwave is not reflected is formed. Namely, by generating plasma in the place (ECR surface) where magnetic field intensity became 875G, and forming a vertical and uniform line of magnetic force to the sample substrate 3 by the microwave introduced from the high magnetic field side, from an ECR surface to the sample substrate 3, The electronic (e^-) movement direction and the movement direction of ion (+) can be arranged. Therefore, charge separation of plasma [as / in a conventional example] does not produce the disordered electric field which was not generated but had been generated with the line of magnetic force of charge separation of plasma and an oblique direction, either. That is, the ion (+) which had a vertical movement ingredient to the sample substrate 3 can be generated so much. As a result, also in the state where the sample substrate 3 kept away from the ECR surface, and has been arranged, the etching process of etching objects (polysilicon etc.) can be performed with a high etch rate.

[0007]Since a high etch rate is obtained as selection ratios (silicon oxide etc.) for a ground even if it does not impress high frequency to a sample table, a high selection ratio is obtained. Since ion (+) enters vertically over the 3rd page of the whole sample substrate to the sample substrate 3 with a vertical line of magnetic force, vertical etching as shown in drawing 3 over the sample substrate 3 whole can be performed without an etching sidewall inclining in sample substrate 3 periphery. Since the sample substrate 3 is separated from the ECR surface, the damage to the sample substrate 3 by heat by microwave can be reduced. Drawing 4 is ECR etching device A" concerning other examples of this invention, and allocates auxiliary coil 7" near the sample substrate 3. Also in this case, like the above-mentioned example, the magnetic field profile by the magnetic field coils 6 and 6 can be changed by auxiliary coil 7', therefore the same effect as the above-mentioned example is done so. As mentioned above, in the magnetic field profile formed with the magnetic coils 6 and 6 and the auxiliary coil 7 (or 7'), Only vacuum housing 4 inner neighborhood of the microwave introducing window 2 is made into a magnetic field required for ECR conditions, and it applies to the sample substrate 3 from there, and is considered as the

magnetic field of uniform magnetic flux density lower than magnetic flux density required for ECR conditions. Therefore, conveying the electron (e^-) and ion (+) in the plasma generated in the ECR field to the sample substrate 3 along with a uniform line of magnetic force, and maintaining high density plasma, while ion (+) had had a vertical component, it enters into the sample substrate 3. As a result, maintaining etching performances, such as a high etch rate and a high selection ratio, an etching configuration can be made vertical to the sample substrate 3, and the damage to the sample substrate 3 can be reduced. Although the one auxiliary coil 7 (or 7') was formed in the above-mentioned example, on the occasion of actual use, both the auxiliary coil 7 and 7' may be provided, or two or more either may be provided. Thus, when two or more auxiliary coils are provided, a magnetic field profile can be changed more finely and the result accuracy of an etching configuration can be raised further. Although the auxiliary coil 7 (or 7') was formed inside the magnetic coils 6 and 6 in the above-mentioned example, even if it provides in the outside (however, neighborhood) of the magnetic coils 6 and 6 on the occasion of actual use, it is convenient in any way. Although the auxiliary coil 7 (or 7') was formed as an auxiliary magnet in the above-mentioned example, even if it provides a permanent magnet instead of an auxiliary coil on the occasion of actual use, it is convenient in any way.

[0008]

[Effect of the Invention]Since the ECR etching device concerning this invention is constituted as described above, In the magnetic field profile formed with a magnetic coil and an auxiliary coil, only the vacuum housing inner neighborhood of a microwave introducing window is made into a magnetic field required for ECR conditions, and it applies to a sample substrate from there, and is considered as the magnetic field of uniform magnetic flux density lower than magnetic flux density required for ECR conditions. Therefore, conveying the electron and ion in the plasma generated in the ECR field to a sample substrate along with a uniform line of magnetic force, and maintaining high density plasma, while ion had had a vertical component, it enters into a sample substrate. As a result, maintaining etching performances, such as a high etch rate and a high selection ratio, an etching configuration can be made vertical to a sample substrate, and the damage to a sample substrate can be reduced.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]

The mimetic diagram showing the outline composition of ECR etching device A' concerning one example of this invention.

[Drawing 2]

The explanatory view showing the magnetic field profile in ECR etching device A', etc.

[Drawing 3]

The section enlarged drawing showing the etching configuration of the sample substrate by ECR etching device A'.

[Drawing 4]

The mimetic diagram showing the outline composition of ECR etching device A" concerning other examples of this invention.

[Drawing 5]

The mimetic diagram showing the outline composition in an example of the conventional ECR etching device A.

[Drawing 6]

The explanatory view showing the magnetic field profile in ECR etching device A, etc.

[Drawing 7]

The section enlarged drawing showing the etching configuration of the sample substrate by ECR etching device A.

[Description of Notations]

A' -- ECR etching device

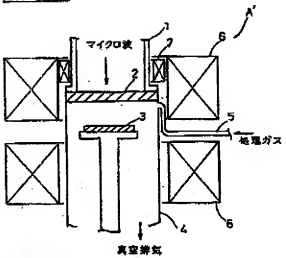
3 -- Sample substrate (equivalent to a sample)

6 -- Magnetic coil (equivalent to a magnetic field generating means)

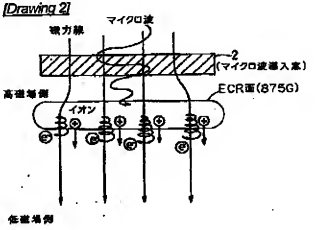
7 -- Auxiliary coil (equivalent to an auxiliary magnet)

DRAWINGS

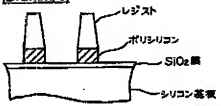
[Drawing 1]



[Drawing 2]



[Drawing 3]



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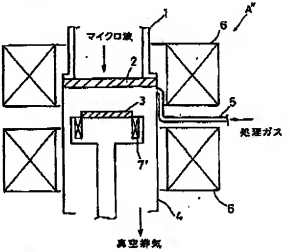
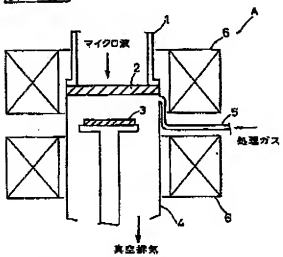
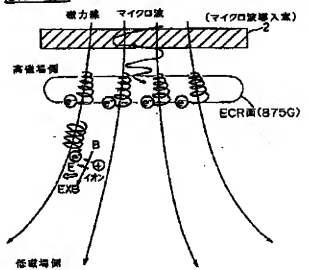


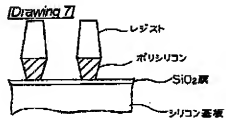
[Drawing 5]



[Drawing 6]



[Drawing 7]



PLASMA GENERATING DEVICE

Publication number: JP11087093
Publication date: 1999-03-30
Inventor: OKUMURA YUTAKA; SATO TAKASHI; TOKUMURA TETSUO; SEGAWA TOSHINORI; NOZAWA TOSHIHISA; ISHIBASHI KIYOTAKA; SHIGEYAMA KAZUKI
Applicant: F O I KK; KOBE STEEL LTD
Classification:
- International: ***H05H1/46; C23C16/50; C23F4/00; H01L21/205; H01L21/302; H01L21/3065; H01L21/31; H01L21/31;*** H05H1/46; C23C16/50; C23F4/00; H01L21/02; (IPC1-7): H01L21/31; H05H1/46; C23C16/50; C23F4/00; H01L21/205; H01L21/3065
- European:
Application number: JP19970250111 19970901
Priority number(s): JP19970250111 19970901

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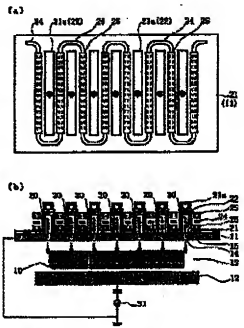
Abstract of JP11087093

PROBLEM TO BE SOLVED: To provide a plasma of excellent quality by providing a magnetic member provided on a second mechanism side and fitted in a plasma generating space, and linearly extending the plasma generating space and the magnetic member along an adjacent surface to a plasma processing space. SOLUTION: A permanent magnet 25 is provided in a plasma generating chamber 21 side, and fitted in a plasma generating space 22, and linearly extended with the plasma generating space 22 along the adjacent surface of the plasma generating space 22 and the plasma processing space 13. Plural permanent magnets 25 and the plasma generating spaces 22 are alternately arranged in parallel with each other. Since the permanent magnets 25 are provided in both sides across the plasma generating space 22, four peaks of magnetism are formed in the periphery of the plasma generating space 22, and the plasma generating space 22 is formed with a basin of magnetism. With this structure, electron is sealed like a bar in a columnar or beam-like plasma generating space 22, and density of plasma is raised.



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H01L 21/205
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// H01L 21/31

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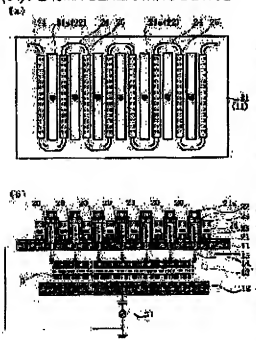
ISHIBASHI KIYOTAKA
SHIGEYAMA KAZUKI

(54) PLASMA GENERATING DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a plasma of excellent quality by providing a magnetic member provided on a second mechanism side and fitted in a plasma generating space, and linearly extending the plasma generating space and the magnetic member along an adjacent surface to a plasma processing space.

SOLUTION: A permanent magnet 25 is provided in a plasma generating chamber 21 side, and fitted in a plasma generating space 22, and linearly extended with the plasma generating space 22 along the adjacent surface of the plasma generating space 22 and the plasma processing space 13. Plural permanent magnets 25 and the plasma generating spaces 22 are alternately arranged in parallel with each other. Since the permanent magnets 25 are provided in both sides across the plasma generating space 22, four peaks of magnetism are formed in the periphery of the plasma generating space 22, and the plasma generating space 22 is formed with a basin of magnetism. With this structure, electron is sealed like a bar in a columnar or beam-like plasma generating space 22, and density of plasma is raised.

CLAIMS

[Claim(s)]
[Claim 1]It has the 2nd mechanism in which attached in the 1st mechanism in which plasma treatment space was formed, and said 1st mechanism, or it was provided in one with it, and plasma generation space was formed, In a plasma generator which said plasma generation space adjoins said plasma treatment space, and is opening for free passage, A plasma generator, wherein it has a magnetic member which was provided in said 2nd mechanism side and given to said plasma generation space and said plasma generation space and said magnetic member are prolonged in linear shape along a contact surface with said plasma treatment space.
[Claim 2]The plasma generator according to claim 1 being what currently two or more said plasma generation space and said magnetic members are provided, and those parts or all are running parallel to.
[Claim 3]The plasma generator according to claim 2, wherein said plasma generation space and said magnetic member are the thing for which all are allocated by turns in part.
[Claim 4]A plasma generator indicated they to be [any of claim 1 thru/or claim 3 being that by which only unreactive gas is supplied to said plasma generation space].

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the plasma generator made to generate plasma using an electric field and a magnetic field in detail about a suitable plasma generator, when performing efficiently plasma treatment, such as etching, membrane formation, and ashing, in highly precise manufacturing processes, such as IC and LCD.
[0002]
[Description of the Prior Art]As a plasma generator used for plasma treatment, such as CVD, etching, ashing, conventionally, Since plasma density runs short, MRIE (magnetron reactive ion etcher) etc. it was made to generate high density plasma (HDP) because a magnetic field also stops plasma in addition are known for the plasma generation of only an applied electric field. The device which was going to prevent the damage by the entropy of the magnetic field which used the planate coil for JP,3-79025,A like the statement is also known.
[0003]Furthermore, In order not to put a processed material to the high density plasma under generating directly, while reducing the damage to the processed material by ion. What pulled apart both space in distance like ECR (electron cyclotron resonance) which divided plasma space into the plasma treatment space which was mutually open for free passage, and plasma generation space, or the thing given in JP,4-81324,A, What confines high density plasma in the plasma generation space contiguous to plasma treatment space like ICP (inductive couple plasma) in a powerful magnetic field, In that furthermore plasma generation space adjoins plasma treatment space, although it is the same, what shuts up high density plasma like a thing given in JP,4-290428,A using the circular polarization electromagnetic waves from a ring antenna is known.
[0004]On the other hand, uniform supply of plasma from a difficult thing in single plasma generation space with large-sized-izing of processing objects, such as a liquid crystal substrate, and extension of plasma treatment space. While allocating two or more plasma generation space in JP,8-222399,A like a statement, there are some which provide a control valve in each and supply reactant gas and raw gas. In this case, plasma generation space is sent in from the place whose magnetism for stopping plasma is a cylindrical upper-and-lower-ends side while being divided into vertical cylindrical space so that an effective area product may not decrease and surrounding each side with the high frequency coil for excitation, even if it plurality-izes.
[0005]
[Problem(s) to be Solved by the Invention]However, although plasma space is divided into plasma generation

space and plasma treatment space and a plasma damage and charge-up reduction are achieved in the plasma generator of these former, If the distance of plasma generation space and plasma treatment space is not much separated, while ionic species will be controlled more than needed, If both space adjoins, the gas which flows backwards from plasma treatment space to plasma generation space will increase. Since it will be made to decompose and ionize violently by high density plasma and will deteriorate in undesirable things, such as a contaminant, in many cases if the ingredient which was generated by processing of a processed material and which should be discharged immediately is also contained in such back run gas and this goes into plasma generation space, it is inconvenient.

[0006]Even if it plurality-izes plasma generation space, this is not canceled while the effective area product from plasma generation space to plasma treatment space has been the same. If a magnet etc. are made to intervene between plasma generation space and plasma treatment space in order to impress the static magnetic bias for stopping plasma from the upper and lower sides of plasma generation space and it is going to secure sufficient magnetism to high density plasma, processing, mounting, etc. of a magnetic member will become troublesome.

[0007]Then, while preventing effectively the undesirable gas stream ON from plasma treatment space to plasma generation space, it becomes a technical problem to devise the structure of plasma generation space, etc. so that mounting of a magnetic member, etc. can be performed easily. it is a plasma generator which is made in order that this invention may solve such a technical problem, and supplies good plasma -- manufacture -- it aims at realizing an easy thing.

[0008]

[Means for Solving the Problem]About the 1st thru/or the 4th solving means invented in order to solve such a technical problem, the composition and operation effect are explained below.

[0009]The [1st solving means] The 1st mechanism in which plasma treatment space was formed as for a plasma generator (it is like a statement to claim 1 of the time of application) of the 1st solving means, In a plasma generator which is provided with the 2nd mechanism in which attached in said 1st mechanism, or it was provided in one with it, and plasma generation space was formed, and said plasma generation space adjoins said plasma treatment space, and is opening for free passage, it had a magnetic member which was provided in said 2nd mechanism side and given to said plasma generation space, and said plasma generation space and said magnetic member are prolonged in linear shape along a contact surface with said plasma treatment space.

[0010]Here, what was formed of a dc energisation coil besides a permanent magnet corresponds to the above-mentioned "magnetic member."

[0011]If it is in a plasma generator of such 1st solving means, By maintaining conditions of separation of plasma space, and a contiguity free passage, it has responded to a fundamental request called a plasma damage, reduction of the charge up, and ratio rationalization with an ingredient of radical species and an ingredient of ionic species in plasma.

[0012]And since a magnetic member given to plasma generation space is provided along both contact surfaces with plasma treatment space by the same 2nd mechanism side as plasma generation space, while strengthening of magnetism is attained, Only a part by which a cross-section area of plasma generation space itself [along a free passage contact surface and also its field with plasma treatment space] was also occupied at least by a magnetic member becomes smaller than that of plasma treatment space inevitably. Thus, when area of both space has a difference, a ratio of area of a free passage contact surface and a cross-section area of plasma treatment space in alignment with this will be made into the 1st ratio, a ratio of area of a free passage contact surface and a cross-section area of plasma generation space in alignment with this will be made into the 2nd ratio, and the 1st ratio will be less than one, and it will be smaller than the 2nd ratio.

[0013]And when the 1st ratio is less than one, gas volume which flows into plasma generation space from plasma treatment space decreases. On the other hand, when the 2nd ratio is 1, gas volume which flows out of plasma generation space into plasma treatment space does not decrease. If the 2nd ratio is larger than the 1st ratio even if the 2nd ratio is a case where the amount of effluent gas decreases by less than one, a grade of reduction will be small and will end. Anyway, a direction of a rate of gas which flows out of plasma generation space into plasma treatment space relatively rather than a rate of gas which flows into plasma generation space from plasma treatment space becomes high. Since the gas will be promptly taken out to plasma treatment space with plasma flow even when an inflow to plasma generation space of undesirable gas not only being controlled by this but gas goes into plasma generation space, Gas deterioration by high density plasma can be prevented and controlled.

[0014]furthermore -- from [carrying out linear shape in this case, although a magnetic member is generally made lacking in processability] -- beforehand -- comparatively -- manufacture -- since processing operation can be managed with making an easy cylindrical thing, and doubling and cutting only length, manufacture of a magnetic member etc. becomes easy. Since a magnetic member is provided in the same 2nd mechanism side as plasma generation space and the necessity of inserting in plasma generation space and plasma treatment space is lost, maintenance services, such as an arrangement design, mounting work, a further next parts replacement, also become easy.

[0015]therefore -- according to this invention, it is a plasma generator which supplies good plasma -- manufacture -- an easy thing is realizable.

[0016]The [2nd solving means] It is a plasma generator of the 1st above-mentioned solving means, two or more said plasma generation space and said magnetic members are provided, and those parts or all are running parallel to a plasma generator (it is like a statement to claim 2 of the time of application) of the 2nd solving means.

[0017]If it is in a plasma generator of such 2nd solving means, an area of distribution of plasma generation space spreads from a line to a field by two or more plasma generation space and running together with a magnetic member. And since it can be made to suit easily since it becomes possible to extend the area without limit by increasing the number of running together even if processing objects, such as a substrate, large-sized-ize, it excels in extendibility.

[0018]The [3rd solving means] A plasma generator (it is like a statement to claim 3 of the time of application) of the 3rd solving means is a plasma generator of the 2nd above-mentioned solving means, and said plasma generation space and said magnetic member are characterized by the thing [that all are allocated by turns in part].

[0019]If it is in a plasma generator of such 3rd solving means, Since a magnetic member is shared by neighboring plasma generation space and it becomes possible to put plasma generation space in order densely while effective use of a magnetic member is made, flexibility for an arrangement design of plasma generation space also improves. Thereby, mounting and manufacture will become still easier.

[0020]The 4th solving means] -- a plasma generator of the 4th solving means -- (-- the time of application -- being according to claim 4 -- it needs --) -- it is the above-mentioned 1st - a plasma generator of the 3rd solving means, and only unreactive gas is supplied to said plasma generation space

[0021]If it is in a plasma generator of such 4th solving means, Only unreactive gas which does not deteriorate undesirably even if it is useful for gas for plasma at generating of high density plasma and becomes high density plasma will be used, and reactant gas required for an etching process will be supplied to plasma treatment space, without passing plasma generation space. It can prevent certainly that reactant gas goes into plasma generation space conjointly by this with inhibition of gas stream ON from plasma treatment space mentioned above to plasma generation space. Then, since deterioration of reactant gas etc. is controlled even if it generates in large quantities, while raising plasma density further if needed, higher quality plasma can be provided compared with a case where reactant gas supply is performed via plasma generation space.

[0022]

[Embodiment of the Invention]Generally the plasma generator of this invention attained by such a solving means is used, equipping a proper vacuum chamber. Therefore, each mechanism part, such as the 1st mechanism in which plasma treatment space is formed, and the 2nd mechanism in which plasma generation space is formed, From viewpoints of aiming at balance of ease, such as inclusion into a vacuum chamber, and the necessity for a degree of vacuum. After forming separately, it is attached in many cases, but it sticks, for example, and although fixed in many cases, it may be formed in one by processing it, a member, for example, a clad plate, or same [all] and single.

[0023]

[Example]About the 1st example of the plasma generator of this invention, a drawing is quoted and the concrete composition is explained. (a) of drawing 1 is the top view.

(b) is drawing of longitudinal section.

Drawing 2 is a vertical section perspective view of the circumference of the plasma generation chamber.

Drawing 3 is an enlarged drawing about the plasma generation space of one in it.

[0024]This plasma generator comprises the 1st mechanism for securing plasma treatment space, the 2nd mechanism for securing plasma generation space and its adjunct, and an impression circuit part for impressing

an electric field or a magnetic field to each plasma in general. In order to process the processed material 1 of square shapes, such as a liquid crystal substrate, as for both the 1st mechanism and the 2nd mechanism, the principal part is mostly formed in rectangular form (refer to drawing 1 (a)).

[0025]The plasma treatment space 13 for low-temperature plasma 10 is formed in the place where the metal cathode parts 12 to which the insulation process of the upper surface was carried out in order that the metal anode part 11 might be arranged up and might **** the processed materials 1, such as a liquid crystal substrate, have been arranged caudad at, and the 1st mechanism was inserted into these. While many interconnecting openings 14 penetrated beforehand and the anode part 11 was punched, the raw gas feed hopper 15 which carried out the opening towards the plasma treatment space 13 was also formed (refer to drawing 1 (b) - vertical section of drawing 3). In this example, it is 0.05, the ratio, i.e., 1st ratio, of the cross sectional area of the interconnecting opening 14, and the effective cross sectional area of the plasma treatment space 13. The thing etc. which made reactant gas, such as CF system gas and silane gas, mix optimum dose of dilution gas as raw gas B supplied to the plasma treatment space 13 via the raw gas feed hopper 15 are supplied.

[0026]As for the 2nd mechanism, the plasma generation chamber 21 made from insulating materials, such as ceramics, serves as a subject.

Two or more straight gashes (drawing 1 (a) seven pieces) used as the plasma generation space 22 engrave this plasma generation chamber 21 in parallel, and are been [straight gashes / it] crowded and formed in it. Thereby, the plasma generation space 22 is a linear shape thing. And the plasma generation chamber 21 is fixed where the opening side (drawing of longitudinal section undersurface) of the plasma generation space 22 is stuck to the upper surface of the anode part 11. In that case, alignment is made so that the opening of the plasma generation space 22 may lap with the interconnecting opening 14 of the anode part 11. This becomes what the plasma generation space 22 and the plasma treatment space 13 adjoined mutually, and was open for free passage, and the plasma generation space 22 becomes what was prolonged in linear shape along the contact surface with the plasma treatment space 13 further. In this example, it is 0.5, the ratio, i.e., 2nd ratio, of the cross sectional area of the interconnecting opening 14, and the cross sectional area of the plasma generation space 22. The value of these ratios may be freely changed, unless size relation is reversed.

[0027]As for the plasma generation chamber 21, the gas feeding route 23 for plasma is too formed in linear shape of the gas distribution member 21a of the plasma generation space 22 further attached in the back (drawing of longitudinal section upper part), Both are opened for free passage by many small holes, and the plasma generation space 22 generates the high density plasma 20 in response to supply of the gas A for plasma generations from a pars basilaris ossis occipitalis (drawing of longitudinal section upper part), and is sending it into the plasma treatment space 13 via the interconnecting opening 14. What does not carry out a chemical reaction with the inertness of argon etc. is used for the gas A for plasma generations.

[0028]As the plasma generation chamber 21 leaves the side attachment wall and pars basilaris ossis occipitalis surrounding the plasma generation space 22, the field (drawing of longitudinal section upper surface) of the reverse side by the side of plasma generation space 22 opening is shaved off. And one permanent magnet 25 (method of drawing-of-longitudinal-section Nakashita), the coil 24, and the permanent magnet 25 (method of drawing-of-longitudinal-section Nakagami) of another side are stuffed there in piles in order. Each permanent magnet 25 is cylindrical and is cut by the almost same length as the plasma generation space 22 (refer to drawing 1 (a)). In order to face across all the plasma generation space 22 with the coil 24 and the permanent magnet 25, the permanent magnet 25 and the coil 24 of a couple are added also to the paries lateralis orbitae of the plasma generation space 22 located in both ends. Thereby, the magnetic member 25 is formed in the 2nd mechanism side, is given to the plasma generation space 22, and has become what was prolonged in linear shape along the contact surface of the plasma generation space 22 and the plasma treatment space 13 with the plasma generation space 22. And the permanent magnet 25 of plurality (inside of a figure eight pairs) and the plasma generation space 22 of plurality (inside of a figure seven pieces) are allocated by turns altogether, and are running parallel to by the parallel condition.

[0029]The height which added the coil 24 to the couple is almost equal to it of the plasma generation space 22, and the permanent magnet 25 is carried out, and it is made suitable [a magnetic pole] in the plasma generation space 22 direction of horizontal (refer to vertical section of drawing 3). If it explains in full detail, since the lines of magnetic flux 26 of the permanent magnet 25 of the method of figure Nakagami which appeared from the lower half in ****** return beside the opposite hand in a figure through the neighborhood of the coil 24, they can do mostly the mountain of the magnetism of the permanent magnet 25 of the method of figure Nakagami which

makes a lower end a summit mostly. The mountain of the almost same magnetism is made also in the place of the upper bed of the permanent magnet 25 of the method of figure Nakashita. Since the permanent magnet 25 is attached to both sides across the plasma generation space 22, four magnetic mountains are made to the surroundings of the plasma generation space 22. So, if it was surrounded by the magnetic mountain and says, a magnetic basin will be made in the plasma generation space 22. And an electron will be caught here. Although explained in the style of a potential field, since it is a vector field in practice, if it states correctly, it will become complicated, but in short as the whole, an electron is cylindrically stopped in the plasma generation space 22 of pillar-shaped and the shape of a beam. It is possible to make the mountain of four magnetism surrounding the section of the plasma generation (refer to drawing 4) space 22 also by arranging in the upper and lower sides of the coil 24 the permanent magnet in which the magnetic pole became up and down. The former is suitable for the densification of plasma and the latter is suitable for equalization of plasma density. Although the graphic display was omitted, it may be made to surround in the mountain of five or more magnetism.

[0030]An impression circuit part is divided into the 1st impression circuit centering on RF power 31, and the 2nd impression circuit centering on RF power 32. RF power 31 is a thing variable in the output power.

While impressing an alternating electric field between the grounded anode parts, in order to also generate bias voltage, the output is fed into the cathode part 12 via a blocking capacitor.

A thing with a frequency of 500 kHz - 2 MHz is well used for this. Thereby, the 1st impression circuit is impressing a certain electric field which carries out grade contribution to strengthening of the low-temperature plasma 10 in the plasma treatment space 13.

[0031]RF power 32 is a thing variable in output power too.

Both the coils 24 that face across the plasma generation space 22 are driven, and alternating field are impressed to the plasma generation space 22.

The maximum output power shall be large and the frequency shall be 13 MHz - 100 MHz in many cases. Thereby, the 2nd impression circuit is impressing the magnetic field which contributes to generating and strengthening of the high density plasma 20 to the plasma generation space 22.

[0032]About the plasma generator of this example, a drawing is quoted and that operating mode and operation are explained. Drawing 5 is a sectional view showing the mounting state to a vacuum chamber.

[0033]In advance of use, the cathode part 12 of a plasma generator is installed in the center of the box-like vacuum chamber body part 2 which the top released. The vacuum chamber body part 2 is attached in the upper part so that opening and closing of the vacuum chamber covering device 3 are possible, the variable valve 4 for vacuum pressure control is made placed between a pars basilaris ossis occipitalis or a flank, and the vacuum pumps 5, such as a turbine pump, are connected. The plasma generation chamber 21 and the anode part 11 are attached, the vacuum chamber body part 2 can also be water-cooled, and if this is shut, the inside and also the plasma treatment space 13, and the plasma generation space 22 of the vacuum chamber body part 2 will also be sealed. And if supply of the gas A for plasma through the gas feeding route 23 for plasma, supply of raw gas B which passes the raw gas feed hopper 15 further, etc. are suitably started while operating the vacuum pump 5, preparation of the plasma treatment to the processed material 1 ****(ed) on the cathode part 12 will be completed.

[0034]Next, when RF power 32 is operated, RF electromagnetic field are impressed via the coil 24 in the plasma generation space 22, and the electron of the gas A for plasma is made to exercise violently. At this time, it flies about, stopping at the plasma generation space 22 for a long time, and carrying out screw motion of the inside of cylindrical space by work of the magnetic circuit by the permanent magnet piece 25, and an electron excites the gas A for plasma. In this way, since many things of the not less than 10-15-eV high energy which contributes to ionic-species generation greatly are contained in the electron confined in the plasma generation space 22, the high density plasma 20 has a ratio of an ionic-species ingredient high although the high density plasma 20 occurs. And as for the high density plasma 20 which expanded in the plasma generation space 22, especially the radical species and an ionic-species ingredient are promptly carried to the plasma treatment space 13 by expansion pressure power.

[0035]If RF power 31 is operated, an RF electric field will be impressed also to the plasma treatment space 13 via the anode part 11 and the cathode part 12. It becomes the low-temperature plasma 10 without making high density plasma even if raw gas B etc. are excited since there is no magnetic circuit which confine an electron here. Since there are few electrons in which the low-temperature plasma 10 had not less than 10-15-eV energy only in the case of the power from RF power 31, the ratio of a radical-species ingredient becomes high. But since the above-mentioned high density plasma 20 is mixed in the case of the low-temperature plasma 10 in this

device, the ratio of a actual radical-species ingredient and ionic-species ingredient turns into which ratio in the middle of both.

[0036]And if the output of RF power 32 is made to raise, the not less than 10-15-eV electrons in the plasma generation space 22 will increase in number. And the generated amount of the high density plasma 20 increases. The rate of an ionic-species ingredient can pull up the low-temperature plasma 10 as a result of the mixing. On the other hand, if the output of RF power 32 is brought down, the not less than 10-15-eV electrons in the plasma generation space 22 will decrease in number. And the generated amount of the high density plasma 20 decreases. As for the low-temperature plasma 10, the rate of an ionic-species ingredient is reduced as a result of the mixing.

[0037]It is as follows when a little output of RF power 32 is brought down, while making the output of RF power 31 raise. First, by the output rise of RF power 31, the electron density in the plasma treatment space 13 shifts to the high density and high energy side, and the low-temperature plasma in the plasma treatment space 13 increases. Although the radical concentration there goes up by this, slight ionic ratio also increases simultaneously. Next, by the output down of RF power 32, the electron density in the plasma generation space 22 shifts to the low density and low energy side, and the high density plasma in the plasma generation space 22 decreases for a while. Although radical concentretion there and ionic ratio fall by this, since these is [the high energy ingredient] large from the first, even if it is a little output downs, ionic ratio falls greatly. And if such high density plasma 20 is mixed by the low-temperature plasma 10 in the plasma treatment space 13, while the change in ionic ratio is offset in general, radical concentration will increase. That is, plasma concentration can pull up the low-temperature plasma 10, without the ratio of a radical-species ingredient and an ionic-species ingredient seldom changing. Similarly, if an opposite direction is made to go up and down the output of RF power 31 and 32, the plasma concentration of the low-temperature plasma 10 will be reduced.

[0038]In this way, the ratio of a radical-species ingredient and an ionic-species ingredient continues broadly easily, and variable control of the low-temperature plasma 10 is carried out. In this device, the cross-section area of the plasma generation space 22 is small far rather than the cross-section area of the plasma treatment space 13, Since the 1st ratio is more nearly extraordinarily [than the 2nd ratio] small, the high density plasma 20 is promptly sent out from the plasma generation space 22 to the plasma treatment space 13, and also. First of all, since there is little gas volume which flows backwards and enters from the plasma treatment space 13 to the plasma generation space 22, raw gas B is directly excited by the high density plasma 20, and most of decomposition and the thing of ionizing is lost until it is undesirable.

[0039]By what 8 sets of permanent magnets 25 and the coil 24 which carried out isomorphism are attached to the plasma generation space 22, and is arranged in the meantime and both the sides. simple – the plasma generation space 22, while there are few magnetic members about a moiety and they end rather than 14 sets needed when the permanent magnet 25 grade has been arranged on each of both sides, Since the high density plasma 20 distributes to the plasma treatment space 13 of rectangular form uniformly and is supplied to it, manufacture of suitable plasma generator and plasma treatment apparatus for uniform processing of a rectangular substrate etc. becomes easy, and, in addition to improved efficiency, it can contribute also to a cost reduction by extension.

[0040]The 2nd example of the plasma generator of this invention which showed drawing 6 the top view is described. That it is different from the 1st example that this mentioned above is the point that the plasma generation chamber 21 grade is formed in disc-like, and a point which the length of the plasma generation space 22 or permanent magnet 25 grade is missing from an end from a center in connection with this, and is short, in order to carry out plasma treatment of the round wafer for IC.

[0041]In this case, although each magnetic member 25 is not necessarily communalized thoroughly, since processing is completed by cutting suitably from being communalized except length so that length may suit, respectively, the ease of processing and manufacture is maintained, without being lost. The advantage which described the 1st example is secured about other points.

[0042]The 3rd example of the plasma generator of this invention which showed drawing 7 the top view is described. That it is different from the 2nd example that this mentioned above is the point that the plasma generation chamber 21 grades are 3 sets from which every 120 degrees of direction differ of allocated things.

[0043]In this case, a round shape can be made to suit better than the thing of the 2nd example, without losing most advantages mentioned above about the 1st example. moreover – although the magnetic member 25 is not the same – ****** – since the surplus material which comes out when it cuts from being considered as near

length suitably so that length may suit, respectively is short, there is also an advantage that the futility of a magnetic member decreases.
[0044]
[Effect of the Invention]If it is in the plasma generator of the 1st solving means of this invention so that clearly from the above explanation, By having carried out as [comfortably / while the shape of plasma generation space and a magnetic member and arrangement are devised and the area ratio of plasma generation space and plasma treatment space changes / processing and mounting of a magnetic member], it is a plasma generator which prevents the inflow of the gas from plasma treatment space to plasma generation space, and supplies good plasma – manufacture – there is an advantageous effect that the easy thing was able to be realized.
[0045]If it is in the plasma generator of the 2nd solving means of this invention, the advantageous effect that the conformity and extendibility to large-sized-izing were able to be raised is done so by having enabled it to extend the distribution side of plasma generation space without limit.
[0046]If it is in the plasma generator of the 3rd solving means of this invention, while aiming at effective use of a magnetic member, there is an advantageous effect that mounting and manufacture were able to be made still easier, by having carried out as [be / putting plasma generation space in order densely / possible].
[0047]If it is in the plasma generator of the 4th solving means of this invention, the advantageous effect that higher quality plasma can be provided now is done so by reactant gas having been made not to be put to high density plasma directly.

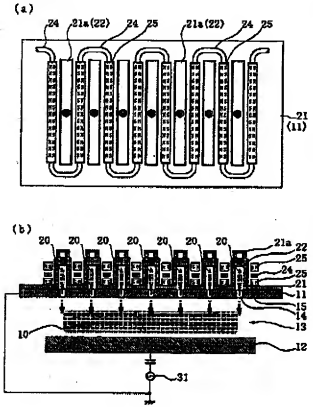
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]About the 1st example of the plasma generator of this invention, (a) is a top view, and (b) is drawing of longitudinal section.
[Drawing 2]It is a vertical section perspective view of the circumference of the plasma generation space.
[Drawing 3]It is an enlarged drawing about the plasma generation space of 1 of them.
[Drawing 4]It is a modification of a magnetic circuit.
[Drawing 5]It is a sectional view showing the mounting state to a vacuum chamber.
[Drawing 6]About the 2nd example of the plasma generator of this invention, it is the top view.
[Drawing 7]About the 3rd example of the plasma generator of this invention, it is the top view.
[Description of Notations]
1 Processed material
2 Vacuum chamber body part
3 Vacuum chamber covering device
4 Variable valve
5 Vacuum pump
10 Low-temperature plasma
11 Anode part (the 1st mechanism; the 1st impression circuit)
12 Cathode part (the 1st mechanism; the 1st impression circuit)
13 Plasma treatment space
14 Interconnecting opening
15 Raw gas feed hopper
20 High density plasma
21 Plasma generation chamber (the 2nd mechanism)
21a Gas distribution member (the 2nd mechanism)
22 Plasma generation space
23 The gas feeding route for plasma
24 Coil (the 2nd impression circuit)
25 Permanent magnet (magnetic member for magnetic circuits)
26 Lines of magnetic flux (magnetic circuit)
31 RF power (the 1st impression circuit)
32 RF power (the 2nd impression circuit)
A argon gas (unreactive gas, gas for plasma production)

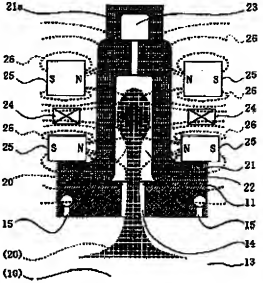
B CF system gas (reactive gas, raw gas)

DRAWINGS

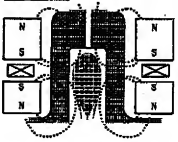
[Drawing 1]



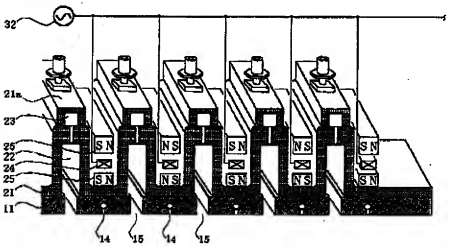
[Drawing 3]



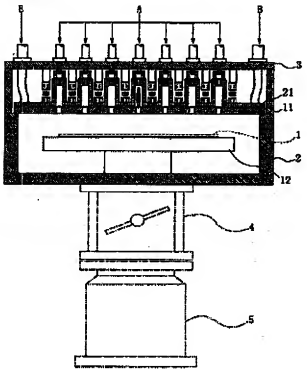
[Drawing 4]



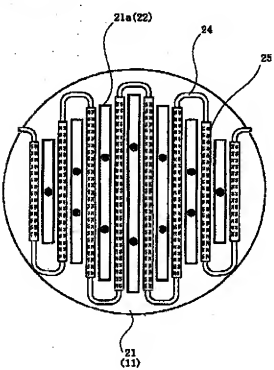
[Drawing 2]



[Drawing 5]



[Drawing 6]



[Drawing 7]